

What is claimed is:

1. An apparatus for conditioning a moving porous paper web on a papermaking machine wherein the web has first and second surfaces and a high temperature gaseous boundary layer adjacent at least the second surface and high temperature gas and/or vapor in pores of the web in flow communication with the first and/or second surfaces of the web, the apparatus comprising:

means for conveying the web adjacent a support having a support surface with the first surface of the web supported adjacent the support surface and the second surface of the web facing away from the support surface;

means for applying a flow of cooling gas against the second surface of the web in order to cause a gas pressure to be exerted against the second surface;

means for stripping away at least a portion of the boundary layer from adjacent the second surface of the web prior to applying the flow of cooling gas thereagainst; and

vacuum means associated with the support surface for exerting a vacuum force upon the first surface of the web supported adjacent the support surface wherein the vacuum force is sufficient to withdraw high temperature gas and/or vapor from at least pores adjacent the first surface of the web into a vacuum chamber included in the vacuum means and wherein the vacuum force is exerted adjacent a location on said first surface functionally adjacent the location at which the gas pressure is exerted against said second surface in order to promote a flow of gas and/or vapor through the web from adjacent the second surface toward the first surface.

2. The apparatus of Claim 1 wherein the moving support comprises a rotating cylinder having a cylindrical perforated surface defining the support surface thereof providing flow communication between the exterior of the cylinder and the interior of the cylinder by flow of gas through the perforations, with the perforated cylindrical surface supporting the first surface of the web adjacent at least a portion of the perforated surface, said vacuum means being disposed within said rotating cylinder closely adjacent the portion of the perforated surface adjacent which the first surface of the web is supported so that high temperature gas and/or vapor withdrawn from the web

by the vacuum force may flow through perforations in the perforated surface and into the vacuum chamber.

3. The apparatus of Claim 1 wherein the means for conveying comprises one or more elements associated with a dryer unit of the papermaking machine upstream of the support and one or more elements associated with a calendar unit of the papermaking machine downstream of the support.

4. The apparatus of Claim 1 wherein the means for conveying comprises one or more elements associated with a dryer unit of the papermaking machine upstream of the support and one or more elements of a web wind-up unit downstream of the support.

5. The apparatus of Claim 1 further comprising means for cooling the support surface.

6. The apparatus of Claim 2 wherein the moving support further includes an endless porous fabric carried, at least in part, on the support surface functionally intermediate the support surface and the first surface of the web so that gas and/or vapor withdrawn from the web may flow through the porous fabric and then into the perforations in the cylinder.

7. The apparatus of Claim 1 wherein the stripping means comprises means for applying a pressurized gas directed substantially tangential to the second surface of the web and substantially opposite to the travel direction of the web.

8. The apparatus of Claim 1 further comprising means for applying a flow of a second cooling gas directed substantially tangential to and in close proximity to the second surface of the web and along the web direction for travel adjacent to and downstream of the moving support so that at least a portion of the second cooling gas develops a boundary layer of cool gas carried adjacent the second surface of the web.

9. The apparatus of Claim 1 further comprising moistening means for applying moisture to the web adjacent to and downstream of the moving support to increase the moisture content of the web.

10. The apparatus of Claim 9 wherein the moistening means comprises a plurality of steam nozzles supported in close proximity to the second surface of the web and connected in flow communication with a source of steam for delivering steam against the second surface of the web through the nozzles so as to cause the steam to condense on and be absorbed by the web.

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11. The apparatus of Claim 1 wherein the means for applying a flow of cooling gas and the vacuum means in conjunction with the web's porosity are sufficient to cause a flow of gas completely through the web from adjacent the second surface to adjacent the first surface.

12. The apparatus of Claim 1 wherein the means for applying a flow of cooling gas comprises at least one nozzle positioned so as to apply the cooling gas against the web in a direction substantially normal to the second surface of the web.

13. The apparatus of Claim 1 wherein the means for applying a flow of cooling gas comprises a plenum having an opening located adjacent the second surface of the web so that cooling gas flows out of the opening toward and against the second surface of the web.

14. The apparatus of Claim 1 wherein the means for stripping comprises an air foil supported functionally adjacent the second surface.

15. A method for conditioning a moving porous web having first and second surfaces, a high temperature gaseous boundary layer adjacent at least the second surface, and high temperature gas and/or vapor in pores in the web in flow

communication with the first and/or second surfaces, the method comprising the steps of:

5 conveying the porous web in a direction of travel adjacent a moving
support having a support surface with the first surface of the web supported adjacent the
support surface and the second surface of the web facing away from the support surface;
 applying a flow of cooling gas against the second surface of the web in
order to cause a gas pressure to be exerted against second surface of the web;
10 stripping away at least a portion of the boundary layer from adjacent the
second surface of the web prior to applying the flow of cooling gas thereagainst; and
 exerting a vacuum force upon the first surface of the web from adjacent
the support surface and at a location functionally adjacent the location on the second
surface against which the cooling gas is applied to promote a flow of gas and/or vapor
15 through the web from adjacent the second surface toward the first surface.

16. The method of Claim 15 further comprising cooling the moving
support .

17. The method of Claim 16 wherein the moving support includes a
perforated surface adjacent which the first surface of the web is supported and the method
further comprises exerting the vacuum force upon the first surface of the web through the
perforations in order to urge a flow of gas and/or vapor from adjacent the first surface of
5 the web into the perforations.

18. The method of Claim 17 wherein the perforated surface includes an
endless porous fabric carried, at least in part, on the moving support.

19. The method of Claim 15 wherein the step of stripping at least a
portion of the boundary layer stripping comprises applying a flow of gas substantially
tangential to the second surface of the web and substantially opposite the web travel
direction.

20. The method of Claim 15 wherein the step of applying cooling gas

comprises applying a second cooling gas directed substantially tangential to the second surface of the web and along the direction of travel of the web so that at least a portion of the second cooling gas forms a boundary layer of cool gas adjacent the second surface of the web.

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21. The method of Claim 15 further comprising moisturizing the web downstream of the location at which the web is supported on the support surface in order to increase the moisture content of the web.

22. The method of Claim 21 wherein the web is moisturized by applying a flow of steam against the web from a plurality of steam nozzles supported functionally adjacent the second surface of the web and connected in flow communication with a source of steam for delivering steam against the second surface of the web through the nozzles so as to cause the steam to condense on and be absorbed by the web.

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23. The method of Claim 15 wherein the cooling gas is applied in a direction substantially normal to the second surface of the web.

24. The method of Claim 15 wherein the cooling gas is applied by a plenum having an opening located functionally adjacent the second surface of the web.

25. The method of Claim 15 wherein the boundary layer is stripped away at least in part by means of an airfoil

26. The method of Claim 15 wherein gas and/or vapor is caused to flow through the web by combined effects of the gas pressure and the vacuum force.

27. An apparatus for conditioning a moving porous paper web on a papermaking machine in a direction of travel wherein the web has first and second surfaces and a high temperature gaseous boundary layer adjacent at least the second surface and high temperature gas and/or vapor in pores of the web in flow communication

5 with the first and/or second surfaces of the web, the apparatus comprising:
a moving support having a support surface with the first surface of the web
supported adjacent the support surface and the second surface of the web facing away
from the support surface;
at least one orifice in flow communication with a cooling gas supply for
10 applying a flow of cooling gas against the second surface of the web in order to cause a
gas pressure to be exerted against the second surface;
at least one air deflector for stripping away at least a portion of the
boundary layer from adjacent the second surface of the web prior to applying the flow of
cooling gas thereagainst; and
15 a vacuum chamber associated with the support surface for exerting a
vacuum force against the first surface of the web supported adjacent the support surface
wherein the vacuum force is sufficient to withdraw high temperature gas and/or vapor
from at least pores adjacent the first surface of the web into the vacuum chamber and
wherein the vacuum force is exerted adjacent a location on said first surface substantially
20 opposed to the location at which the pressure force is maintained adjacent said second
surface in order to promote a flow of gas through the web from adjacent the second to
adjacent the first surface and into the vacuum chamber.

28. The apparatus of Claim 27 wherein the moving support comprises a
rotating cylinder having a cylindrical perforated surface defining the support surface
thereof providing flow communication between the exterior of the cylinder and the
interior of the cylinder by flow of gas through the perforations, with the perforated
5 cylindrical surface supporting the first surface of the web adjacent at least a portion of the
perforated surface, said vacuum chamber being disposed within said rotating cylinder
closely adjacent the portion of the perforated surface adjacent which the first surface of
the web is supported so that high temperature gas and/or vapor withdrawn from the web
by the vacuum force pass through perforations in the perforated surface and into the
10 vacuum chamber.

29. The apparatus of Claim 27 further comprising at least one nozzle in

flow communication with a cooling gas for cooling the support surface.

30. The apparatus of Claim 28 wherein the moving support further includes an endless porous support fabric carried on the support surface between the support surface and the first surface of the web so that gas and/or vapor withdrawn from the web passes through the support fabric and then into the perforations in the cylinder.

31. The apparatus of Claim 27 further comprising at least one nozzle for applying a pressurized gas directed substantially tangential to the second surface of the web and substantially opposite to the web travel direction and upstream of the moving support.

32. The apparatus of Claim 27 further comprising at least one nozzle for applying a flow of a second cooling gas directed substantially tangential to the second surface of the web and along the web travel direction adjacent to and downstream of the moving support so that at least a portion of the second cooling gas develops a boundary layer of cool gas carried adjacent the second surface of the web.

33. The apparatus of Claim 27 further comprising a moistening gas source for applying moist gas to the web adjacent to and downstream of the moving support to increase the moisture content of the web.

34. The apparatus of Claim 32 wherein the moistening gas source comprises a plurality of steam nozzles supported in close proximity to the second surface of the web and connected in flow communication with a source of steam for delivering steam against the second surface of the web through the nozzles so as to cause the steam to condense on and be absorbed by the web.

35. The apparatus of Claim 27 wherein the flow of cooling gas and the vacuum chamber in conjunction with the web's porosity are sufficient to cause a flow of gas through the web from adjacent the second to adjacent the first surface.